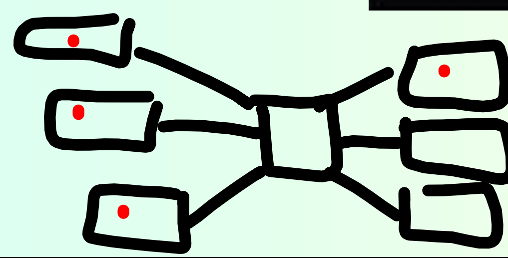
(6) M - State best practice techniques for applying equations of motion
(7) S - Apply equations of motion to situations involving half parabolas
(8) C - Apply equations of motion to situations involving objects with v at an angle

Lesson 8. Projectile motion 2

STARTER: What are you top tips for completeing a projectiles/suvat question?



HWK (due next lesson):

Kilo 10^3

Mega 10^6

Giga 10^9

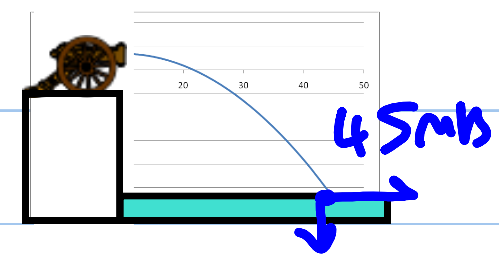
What are the problem if these tip are not done?

Key point

(6) M - Describe how gases exert a pressure on a surface
(7) S - Describe the relationship between pressure and temperature
(8) C - Explain how to see evidence of gas molecules moving at random

Example:

A cannon ball is 20m high up a tower and is fired with a velocity of 45m/s



(a) How long it takes to reach the ground

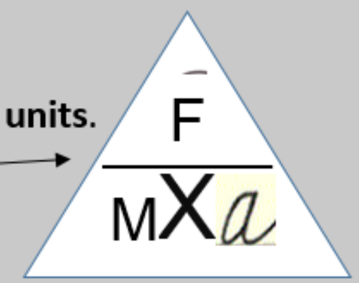
(b) the distance it lands from the foot of the cliff

(c) the vertical and horizontal velocities just before it hits the ground

Key
poir

The 4 part method:

1. Write out all the **data**/quantities you have in the correct **units**.
2. Select the correct **equation** (rearrange?)
3. **Substitute** values into the equation.
4. Write your **answer** with the **unit**.

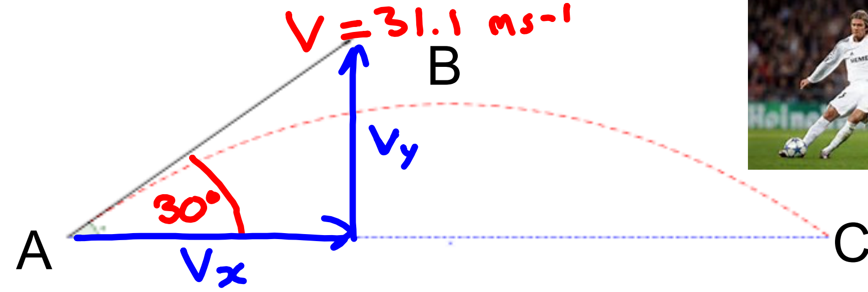


(6) M - Describe how gases exert a pressure on a surface
(7) S - Describe the relationship between pressure and temperature
(8) C - Explain how to see evidence of gas molecules moving at random

Key point

Projection at an angle

- Greatest height is reached when vertical velocity = $0 ms^{-1}$.
- Time taken to B = half time taken from A to C.
- Total Vertical displacement = 0
- Initial velocity has to be split into its vertical and horizontal co



David Beckham takes a free kick. He kicks the ball at an angle of 30° to the
ground at a velocity of $31.1 ms^{-1}$ (Roberto Carlos - world record fastest free
kick).

Find:

(a) Total time taken

(b) How far away the ball lands

(c) The maximum height reached

(6) M - Describe how gases exert a pressure on a surface
(7) S - Describe the relationship between pressure and temperature
(8) C - Explain how to see evidence of gas molecules moving at random

ACTIVITY 1: Complete summary questions 2-4 and self assess.

ACTIVITY 1: Complete the exam style questions

HWK (due next lesson):

Kilo 10^3

Mega 10^6

Giga 10^9 Lowe P41 Q9 / Lowe P42 Q15

Key point

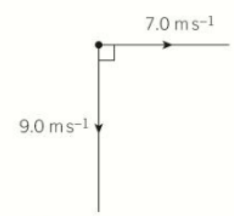
Summary questions

1 A ball is kicked into the air. Figure 8 shows the velocity components of the ball at a particular instant. Calculate the velocity *v* of the ball. (*2 marks*)

2 A cannonball is fired horizontally from a cliff 29 m above the sea. The initial horizontal velocity of the cannonball is 320 m s^{-1}. Calculate:
- **a** the time of flight; (*3 marks*)
- **b** the horizontal distance it travels; (*3 marks*)
- **c** the speed at which it hits the sea. (*3 marks*)

3 A cannonball is fired at 22.0 m s^{-1} at 35° to the horizontal. Calculate:
- **a** the maximum vertical height of the ball; (*4 marks*)
- **b** the horizontal distance travelled by the ball. (*5 marks*)

4 Sketch the vertical velocity–time graph for the cannonball in **2**. (*3 marks*)



▲ Figure 8

(6) M - Describe how gases exert a pressure on a surface
(7) S - Describe the relationship between pressure and temperature
(8) C - Explain how to see evidence of gas molecules moving at random

0:08:00

A golfer is about to hit a golf ball from a tee to a hole on the green. The tee and the green are at the same level, as shown in Figure 4.

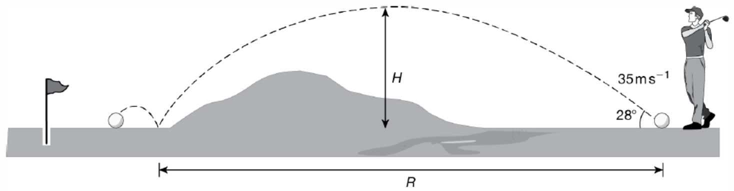


Figure 4

The golfer would like the ball to land on the front edge of the green, and selects a club that will project the ball at 28° to the horizontal. The ball is hit so that it is projected from the face of the club with a speed of 35 m s^{-1}.
Air resistance is negligible.
Calculate:

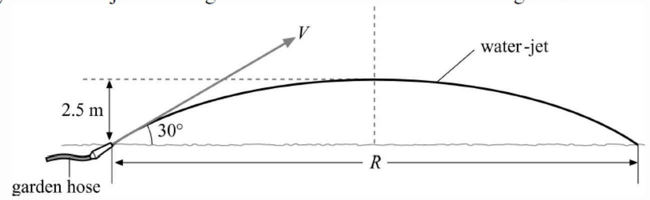
Kilo 10^3 **i** the horizontal distance, *R*, travelled by the ball before first landing on the green

Mega 10^6 the maximum height, *H*, reached by the ball above the level of the tee.

Giga 10^9

Key point

10 The trajectory of a water-jet from a garden hose is as shown in the diagram.



You may assume that air resistance has a negligible effect on the motion of the water-jet. Use the information provided above to determine the speed *V* of the water emerging from the pipe and the range *R*. [6]

10 Vertically for motion from the hose to the highest point ⇒

$u = V \sin 30°$ $\quad s = 2.5$ m $\quad a = -9.81$ m s^{-2} $\quad v = 0$ [1]

$v^2 = u^2 + 2as$

$0 = (V \sin 30°)^2 - (2 \times 9.81 \times 2.5)$ [1]

$(0.5V)^2 = 2 \times 9.81 \times 2.5$

$V = \sqrt{\dfrac{2 \times 9.81 \times 2.5}{0.5^2}} \approx 14 \text{ m s}^{-1}$ [1]

Vertically for motion from the hose back down to the ground ⇒

$u = 14 \sin 30° = 7.0 \text{ m s}^{-1}$ $\quad v = -7.0 \text{ m s}^{-1}$ $\quad a = -9.81 \text{ m s}^{-2}$ $\quad t = ?$

$v = u + at$ where t = total time of flight

$t = \dfrac{-7.0 - 7.0}{-9.81} = 1.43 \text{ s}$ [1]

Horizontally ⇒

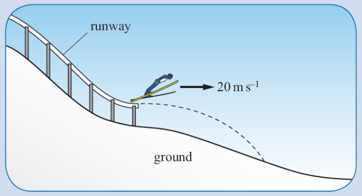
range $= (V \cos 30°)t = 14 \cos 30° \times 1.43$ [1]

range $= 17.3 \text{ m} \approx 17 \text{ m}$ [1]

(6) M - Describe how gases exert a pressure on a surface
(7) S - Describe the relationship between pressure and temperature
(8) C - Explain how to see evidence of gas molecules moving at random

0:08:00

5 A ski jumper skis down a runway and projects himself into the air, landing on the ground a short time later. The mass of the ski jumper and his equipment is 80 kg. The diagram shows the skier just before he leaves the runway where his velocity is $20\,\text{m s}^{-1}$ in a horizontal direction.



a The skier lands 4.0 s after leaving the runway. Assume that only a gravitational force acts on the skier. Calculate:

i the horizontal distance travelled by the skier in 4.0 s [1]

ii the vertical fall of the skier in this 4.0 s [3]

iii the horizontal component of the skier's velocity immediately before he lands [1]

iv the vertical component of the skier's velocity immediately before he lands. [2]

b Name two forces that act on the skier when he is in the air. [2]

Hint

OCR Physics AS (2821) January 2002

Kilo 10^3 Use the hint

Mega 10^6

Giga 10^9 Use the hint

Hint

The horizontal velocity remains constant at $20\,\text{m s}^{-1}$. In the vertical direction, the initial velocity u is zero and the vertical motion is affected by the force of gravity. Hence, in the vertical direction, the acceleration is g.

a i Distance $= 20 \times 4.0 = 80\,\text{m}$ [1]

ii $s = ut + \frac{1}{2}at^2$ [1]

$s = 0 + \frac{1}{2} \times 9.81 \times 4.0^2$ [1]

Vertical fall = 78 m [1]

iii Horizontal component $= 20\,\text{m s}^{-1}$ [1]

iv $v = u + at$

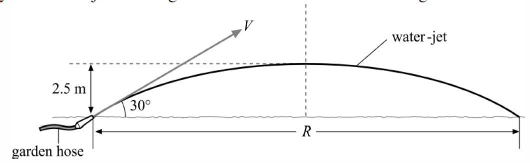
$v = 0 + (9.81 \times 4.0)$ [1]

$v = 39\,\text{m s}^{-1}$ [1]

b Any two from: air resistance, weight and lift. [2]

Key point

10 The trajectory of a water-jet from a garden hose is as shown in the diagram.



You may assume that air resistance has a negligible effect on the motion of the water-jet. Use the information provided above to determine the speed V of the water emerging from the pipe and the range R. [6]

10 Vertically for motion from the hose to the highest point ⇒

$u = V \sin 30°$ $\quad s = 2.5\text{ m}$ $\quad a = -9.81\text{ m s}^{-2}$ $\quad v = 0$ [1]

$v^2 = u^2 + 2as$

$0 = (V \sin 30°)^2 - (2 \times 9.81 \times 2.5)$ [1]

$(0.5V)^2 = 2 \times 9.81 \times 2.5$

$V = \sqrt{\dfrac{2 \times 9.81 \times 2.5}{0.5^2}} \approx 14\text{ m s}^{-1}$ [1]

Vertically for motion from the hose back down to the ground ⇒

$u = 14 \sin 30° = 7.0\text{ m s}^{-1}$ $\quad v = -7.0\text{ m s}^{-1}$ $\quad a = -9.81\text{ m s}^{-2}$ $\quad t = ?$

$v = u + at$ where t = total time of flight

$t = \dfrac{-7.0 - 7.0}{-9.81} = 1.43\text{ s}$ [1]

Horizontally ⇒

range $= (V \cos 30°)t = 14 \cos 30° \times 1.43$ [1]

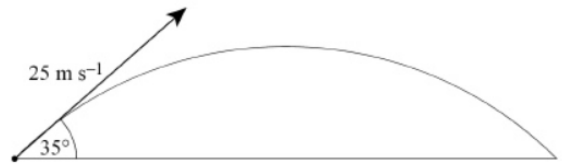
range $= 17.3\text{ m} \approx 17\text{ m}$ [1]

(6) M - Describe how gases exert a pressure on a surface
(7) S - Describe the relationship between pressure and temperature
(8) C - Explain how to see evidence of gas molecules moving at random

plenary

0:00:00

A projectile is launched with a speed of 25 m s^{-1} at an angle of 35° to the horizontal, as shown in the diagram.



Air resistance is negligible.

What is the time taken for the projectile to return to the ground?

A 1.5 s

B 2.1 s

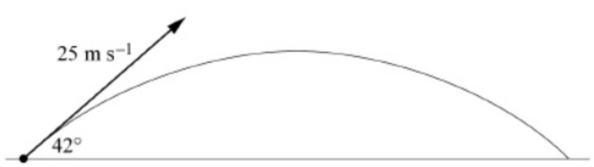
C 2.9 s

D 4.2 s

(Total 1 mark)

c

The diagram shows the path of a projectile launched from ground level with a speed of 25 m s^{-1} at an angle of 42° to the horizontal.



What is the horizontal distance from the starting point of the projectile when it hits the ground?

A 23 m

B 32 m

C 47 m

D 63 m

(Total 1 mark)

d